



Inter-Satellite Comparison and Evaluation of Navy SNPP VIIRS and MODIS Aqua Ocean Color Properties

Paper # 9111-06

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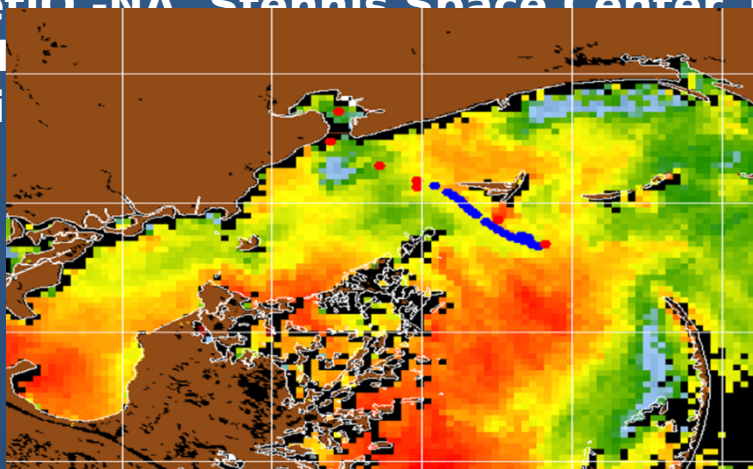
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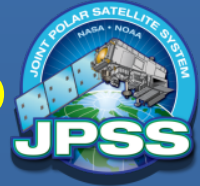
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Objectives

- **Evaluate the inter-comparison and accuracy of ocean color products from SNPP VIIRS and MODIS Aqua in coastal waters of the Northern Gulf of Mexico**
 - **rrs(l)** - remote sensing reflectance
 - **total absorption (a), backscattering (bb), beam attenuation (c) and chlorophyll**
- **Calibration & Validation Ship Cruises**
 - **SEP 2013; NASA GEO-stationary Coastal and Air Pollution Events (GEOCAPE)**
in Northern Gulf of Mexico from Galveston Bay, TX to Miss. River
Delta, LA (coastal, shelf, offshore) ☑ rrs(l), a(l), c(l)
 - **NOV 2013; NRL Ocolor Cruise in Miss. Sound south of Bay St. Louis, MS (coastal) ☑ rrs(l), bb440, a(l), c(l)**



Operational Software for NPP VIIRS

and MODIS Aqua Ocean Color Processing

1. APS/n2gen software (NRL, NASA) - R&D

- 1. Calibration applied to VIIRS SDR (AFWA IDPS/NAVO, NOAA IDPS/CLASS)**
- 2. Atmospheric correction - GW NIR w/ 80 aerosol models**
- 3. Vicarious Gains Applied - VIIRS(NRL/MOBY), MODIS Aqua (NASA/MOBY)**
- 4. Glint / Cloud Removal**
- 5. In-water Algorithms - Quasi Analytical Algorithm (QAA)**

Coastal iteration

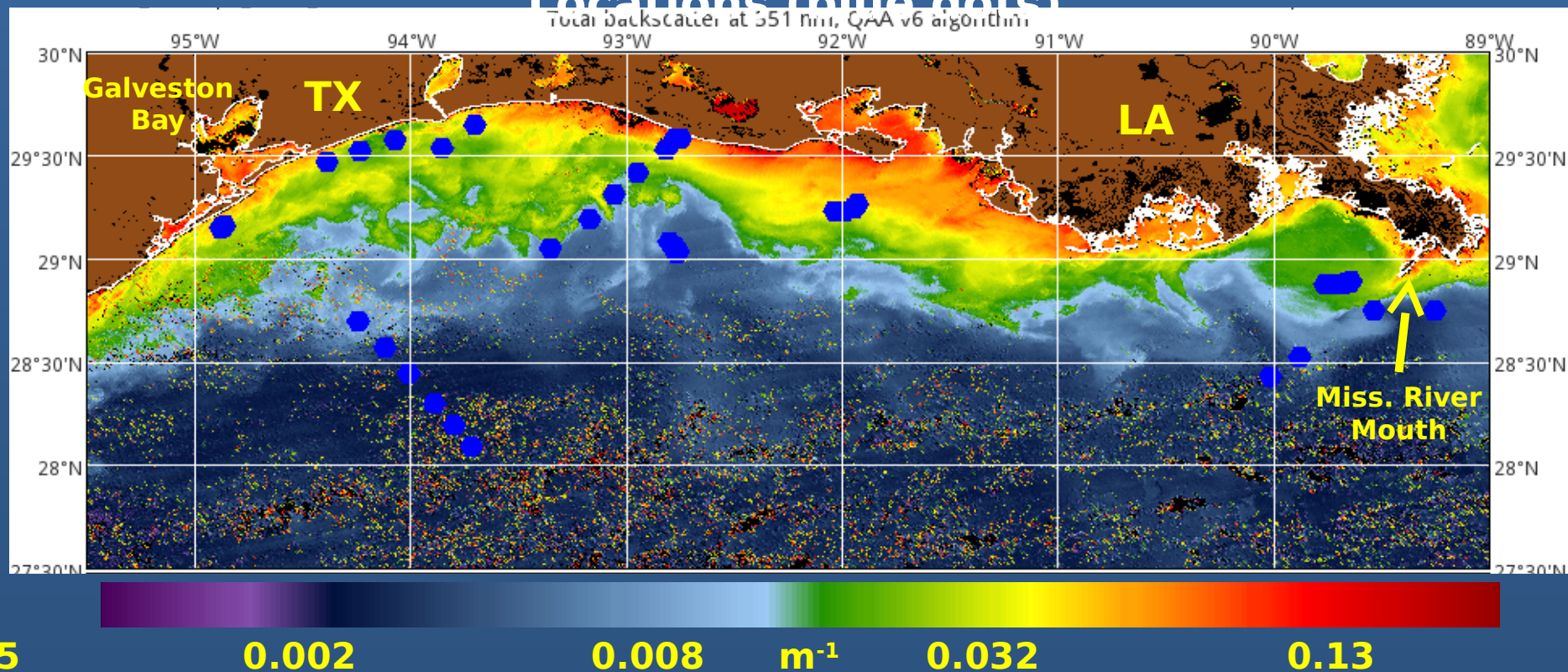
MOBY: calibration standard located off the coast of Hawaii in a blue water stable environment with minimal



GEOCAPE Cruise (Northern GoMex) September 09 - 19, 2013



**VIIRS Mean Backscattering @551nm (QAA) w/ Station
Locations (blue dots)**



05

Insitu Data: rrs(I) collected by NOAA(Ondrusek) using a Satlantic Hyperpro (in-water) and by UMASS (Lee, Pahlevan) using a HyperOCR (skylight-blocked approach above water). IOP's collected Wetlab's Hyperspectral ACS absorption and beam attenuation meter (a, c) and ECOPUC (bb).

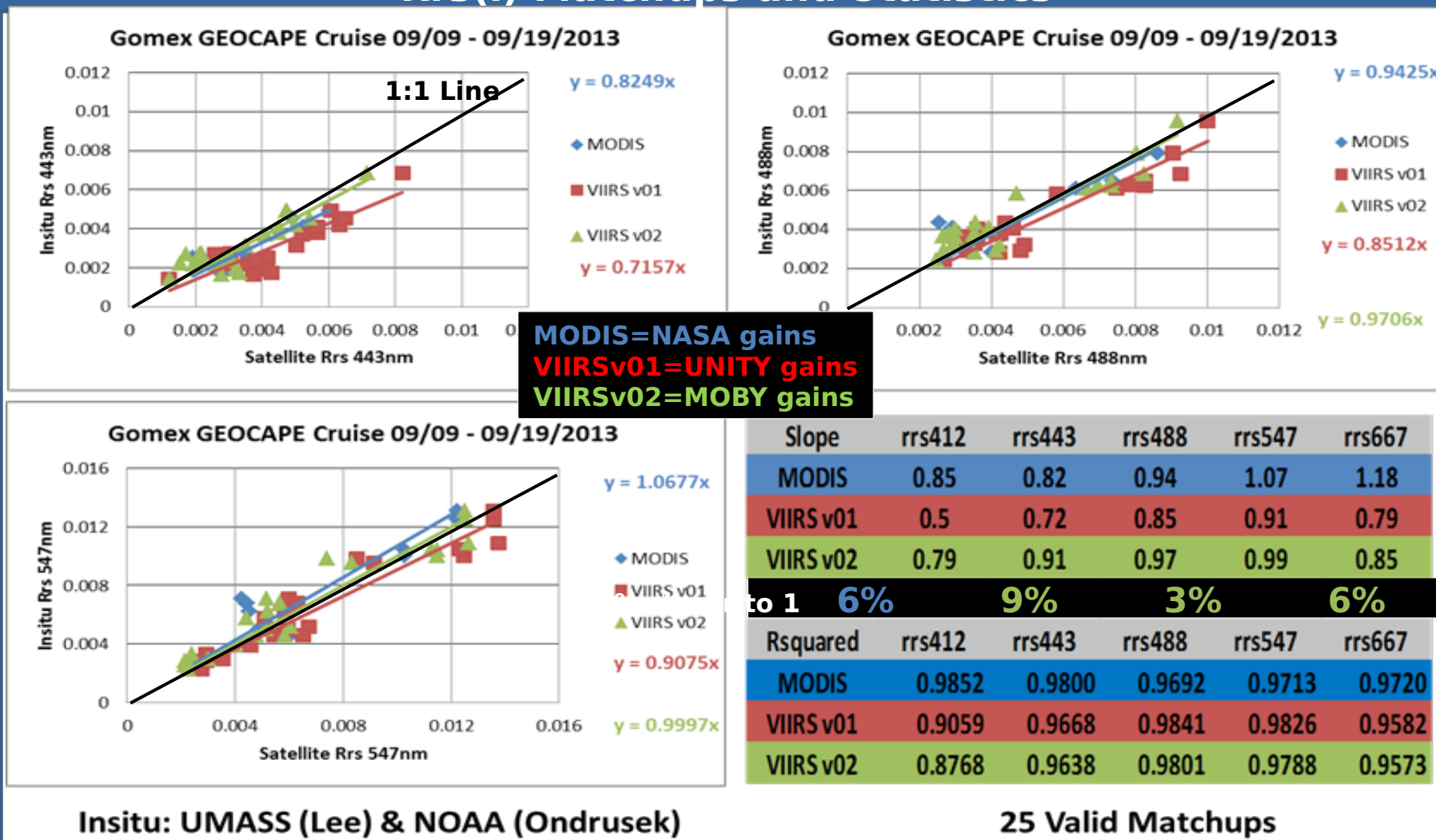
Valid Matchups: Insitu data was used if positive and passed QC satellite



GEOCAPE Cruise (Northern GoMex) September 09 - 19, 2013



Rrs(I) Matchups and Statistics



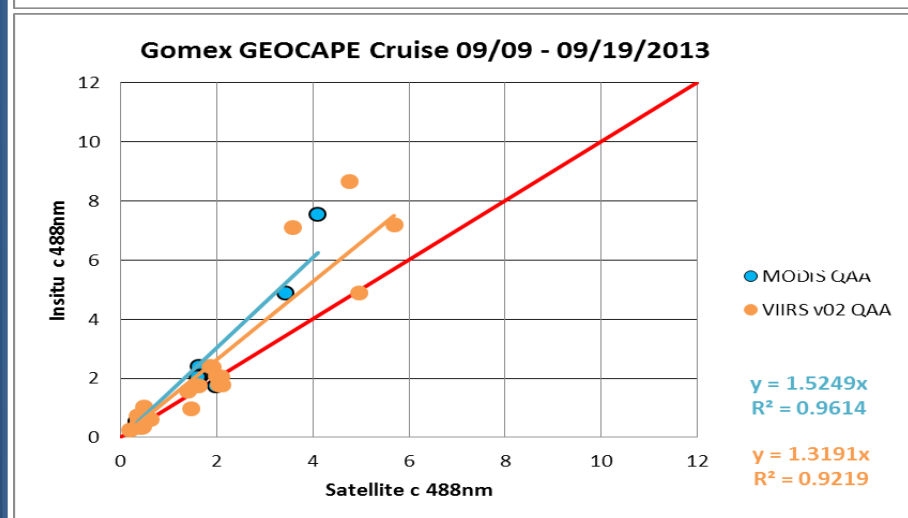
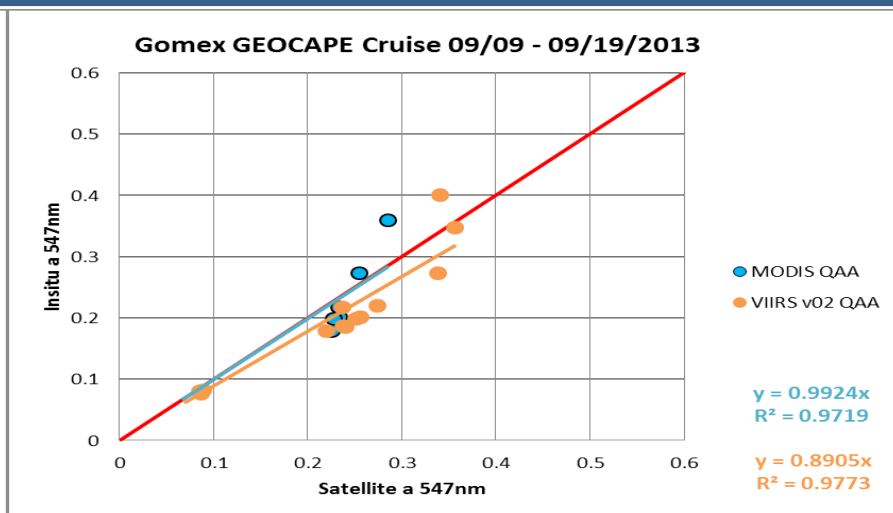
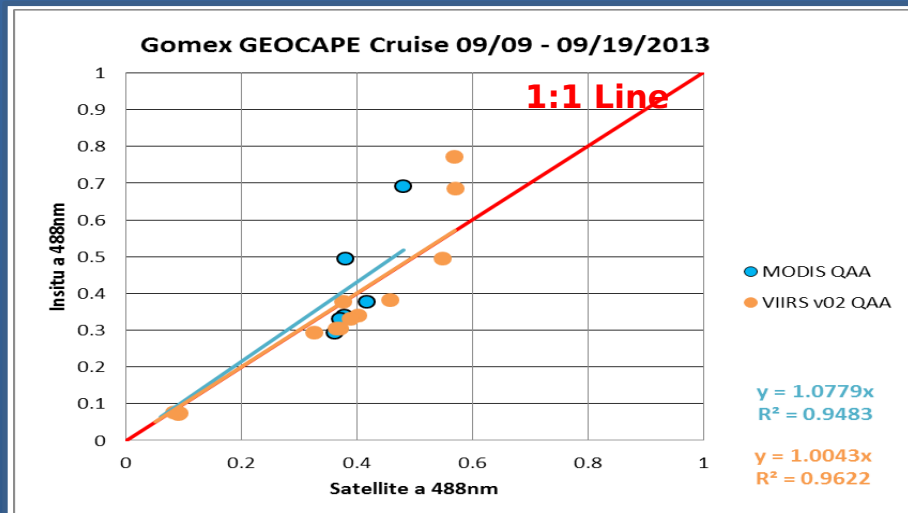
Rrs: Overall VIIRS and MODIS performing well; VIIRS better (closer to 1:1 except for 412nm)



GEOCAPE Cruise (Northern GoMex) September 09 - 19, 2013



IOP(I) Matchups and Statistics



SLOPE	a412	a443	a488	a547	c412	c443	c488	c547
ModQAA	1.24	1.30	1.08	0.99	1.41	1.51	1.52	1.54
VIIRSQAA	1.21	1.32	1.00	0.89	1.11	1.27	1.32	1.33
to 1	3%	2%	8%	10%	30%	24%	20%	20%
R2	a412	a443	a488	a547	c412	c443	c488	c547
ModQAA	0.93	0.96	0.95	0.97	0.95	0.96	0.96	0.97
VIIRSQAA	0.93	0.88	0.96	0.97	0.92	0.93	0.92	0.93

Insitu: UMASS

Overall VIIRS and MODIS QAA both performing well; BOTH have similar slopes for absorption while VIIRS produces much better beam-c values

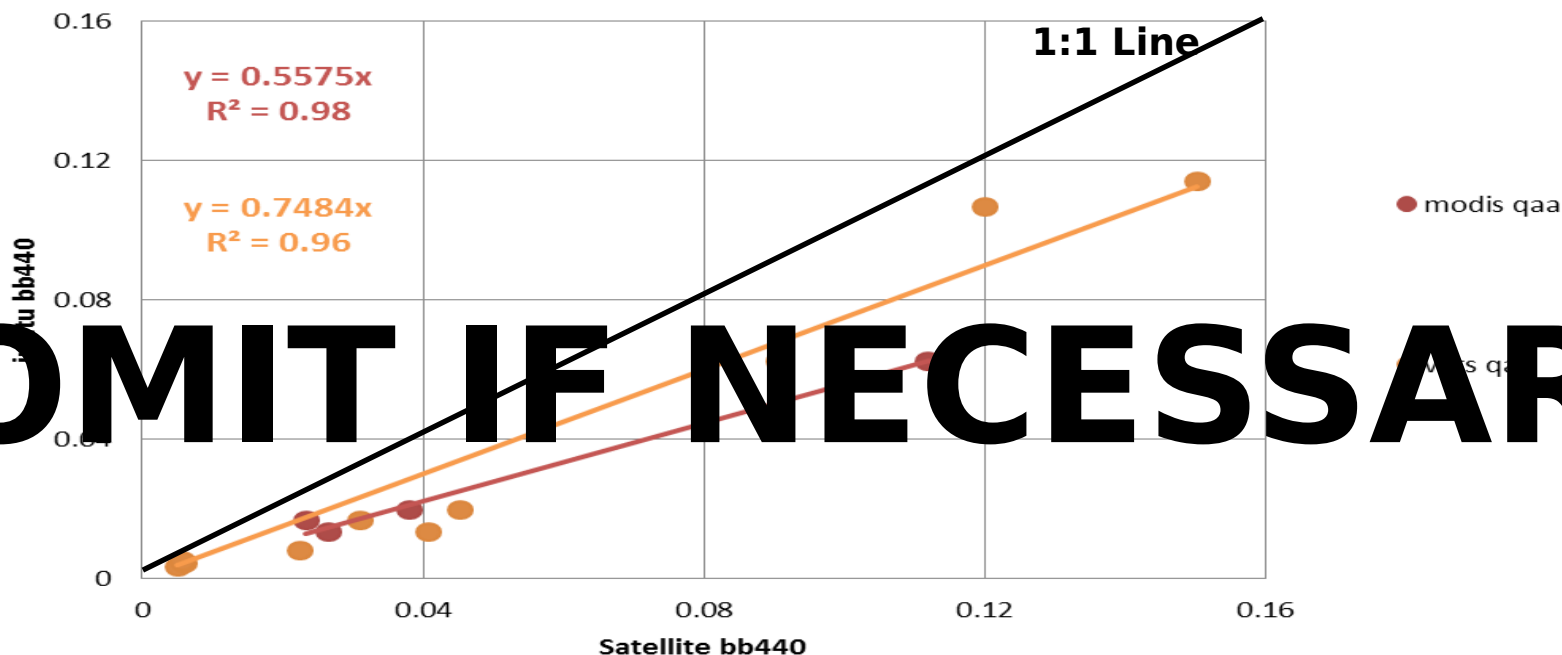


GEOCAPE Cruise (Northern GoMex) September 09 - 19, 2013



bb(440) Matchups and Statistics

GEOCAPE July 9-19, 2013



NOAA ECOPUC Data
(Ondrusek)

bb440	Rsquared	Slope
modis qaa	0.9895	0.5600
viirs qaa	0.9586	0.7500

bb440: VIIRS matchups are better (slope 0.75) and overestimated by 44%
bb440: MODIS had fewer points (5) and is overestimated by 44%

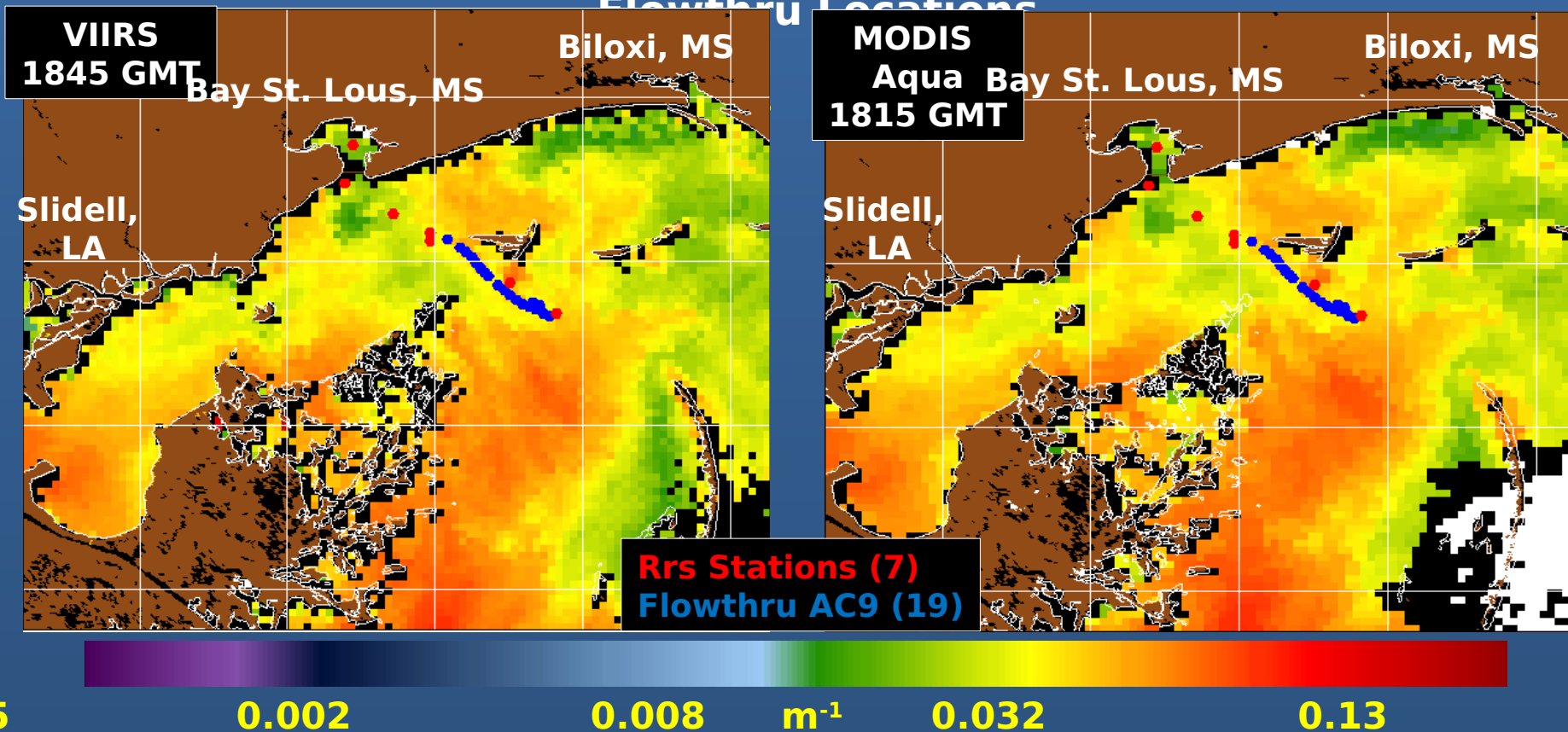


NRL Ocolor Cruise (Mississippi Sound)

November 20, 2013



VIIRS vs. MODIS Backscattering @551nm (QAA) w/ Station & Flowthru Locations



05

In situ Data: NRL(Goode) - above water rrs(l) - hyperspectral handheld Analytical Spectral Devices (ASD). IOP's Wetlab's Hyperspectral AC9 absorption and beam attenuation meter (a, c) in continuous flowthru mode. Flowthru collected over a 20km track and binned to ~1km to match satellite resolution.

Valid Matchups: In situ data was used if position and passed QC satellite

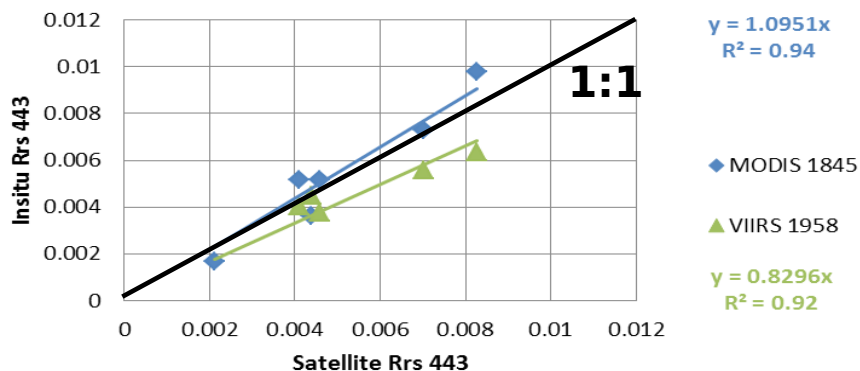


NRL Ocolor Cruise (Mississippi Sound) November 20, 2013

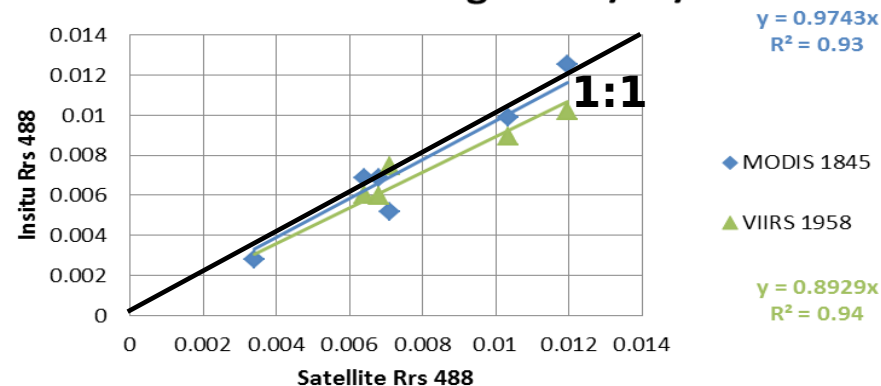


Rrs(I) Matchups and Statistics

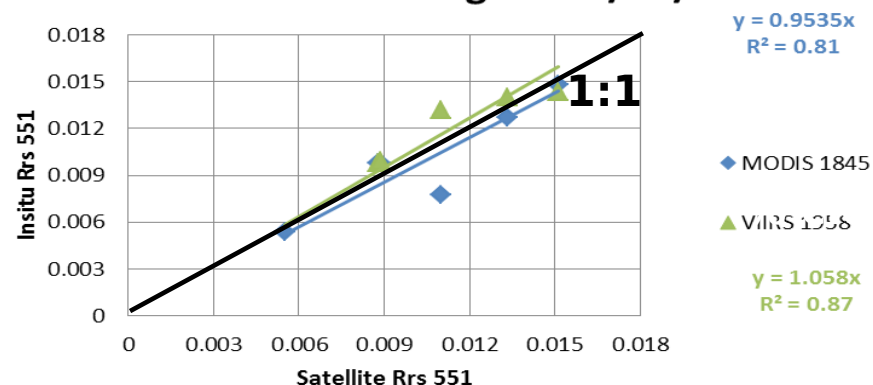
RV Ocolor - MissBight - 11/20/13



RV Ocolor - MissBight - 11/20/13



RV Ocolor - MissBight - 11/20/13



Slope	rs443	rs488	rs547
MODIS 1845	1.09	0.97	0.95
VIIRS 1957	0.83	0.89	1.06
Percent Error to 1	8%	8%	
Rsquared	rs443	rs488	rs547
MODIS 1845	0.94	0.93	0.81
VIIRS 1957	0.92	0.94	0.87

Insitu: NRL

Rrs: Overall VIIRS and MODIS performing well; MODIS better (closer to 1:1)

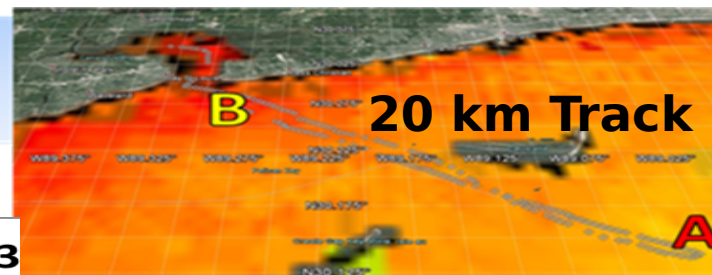


NRL Ocolor Cruise (Mississippi Sound) November 20, 2013

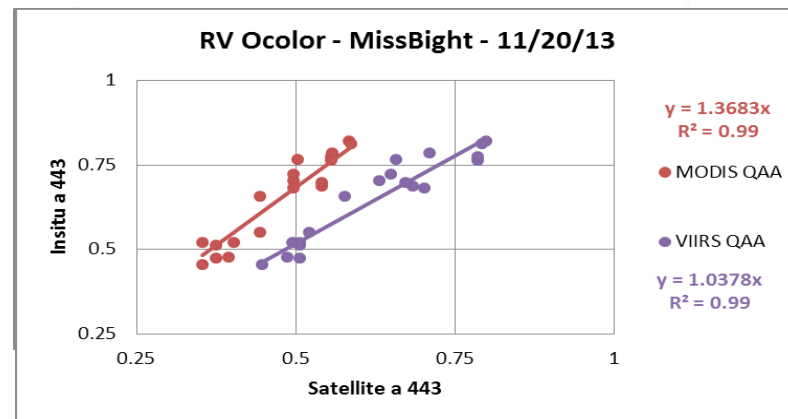
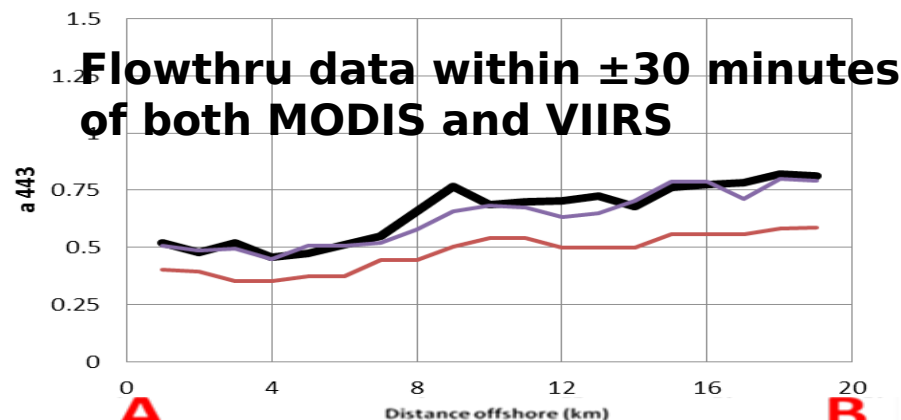


IOP(I) Matchups (Flowthru) and Statistics

Flowthrough IOPs –Total
absorption (443 nm)



RV Ocolor - MissBight - 11/20/13



SLOPE		a412	a443	a488	a547	c412	c443	c488	c547
ModQAA		1.4719	1.3683	1.1459	0.8762	1.3836	1.4048	1.4270	1.4263
VIIRSQAA		0.8398	1.0374	0.9853	0.8244	1.3357	1.4410	1.4748	1.4678
%closer to 1		31%	33%	14%	6%	4%	4%	3%	4%
R2		a412	a443	a488	a547	c412	c443	c488	c547
ModQAA		0.9968	0.9966	0.9961	0.9974	0.9875	0.9872	0.9871	0.9873
VIIRSQAA		0.9929	0.9966	0.9958	0.9965	0.9915	0.9914	0.9908	0.9909

**19 - 1km
bins/matchups**

Insitu: NRL

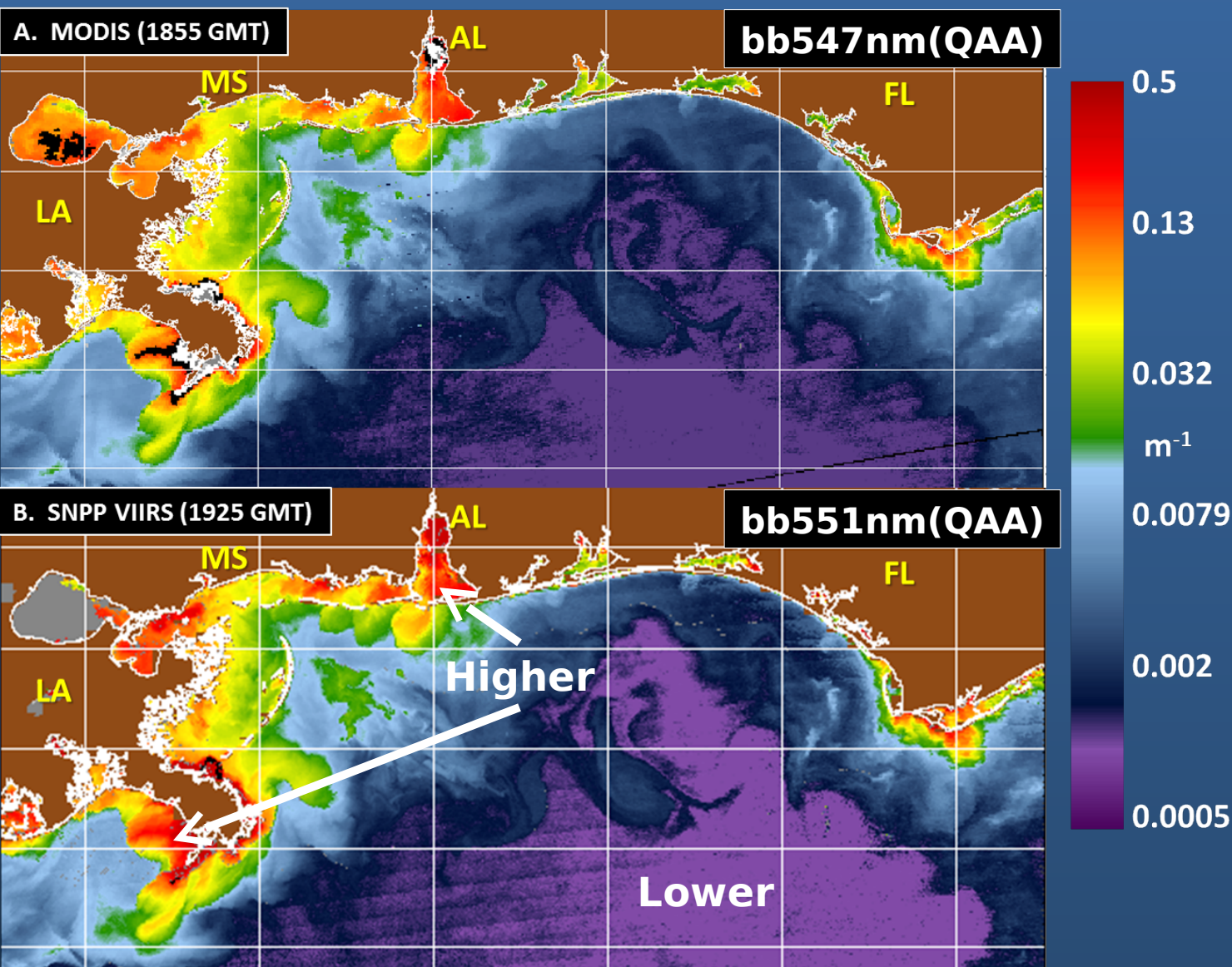
Conclusion: Overall VIIRS slopes better than MODIS except for 547nm (mean error ~9%, ~43%); Overall MODIS slopes little better than VIIRS except for 412nm (mean error ~43%, ~9%)



MODIS vs. VIIRS Comparison

MissBight

February 15, 2014

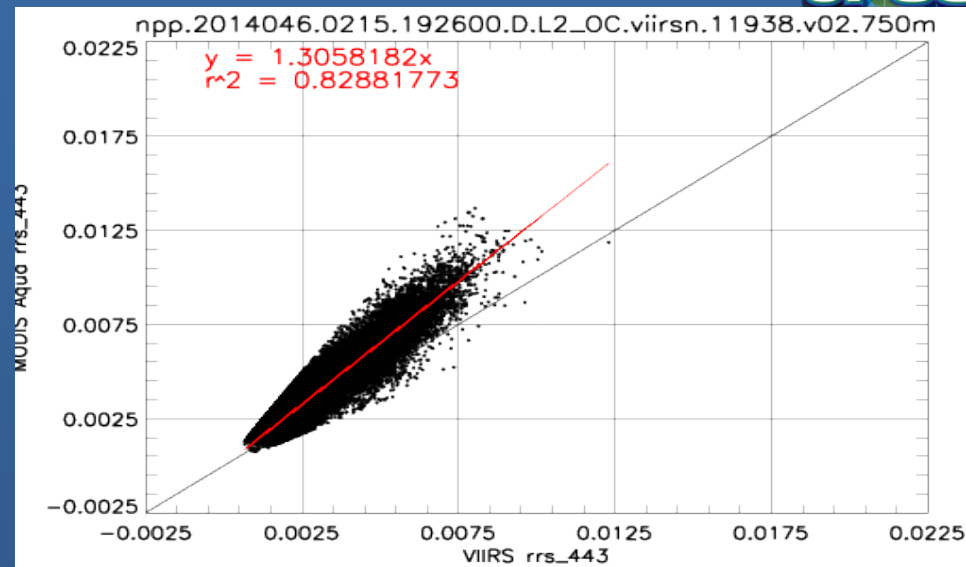
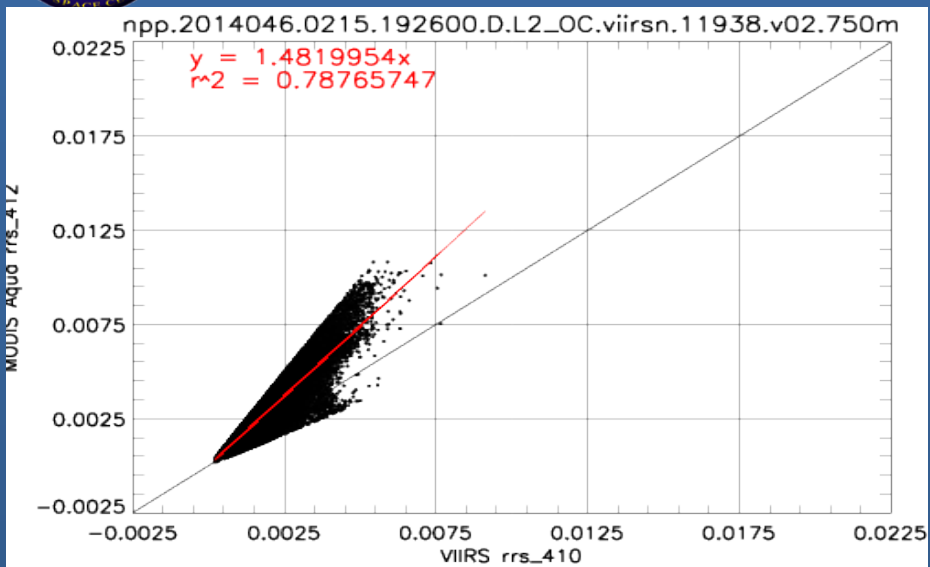


**VIIRS
bb551nm
values
derived from
the QAA
algorithm
are slightly
higher in the
coastal
region and
lower
offshore.**

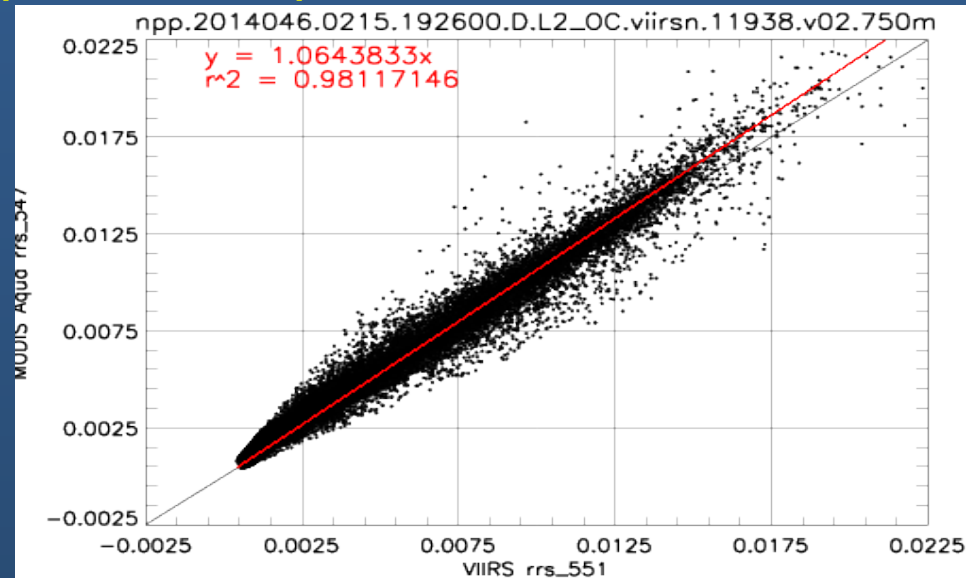
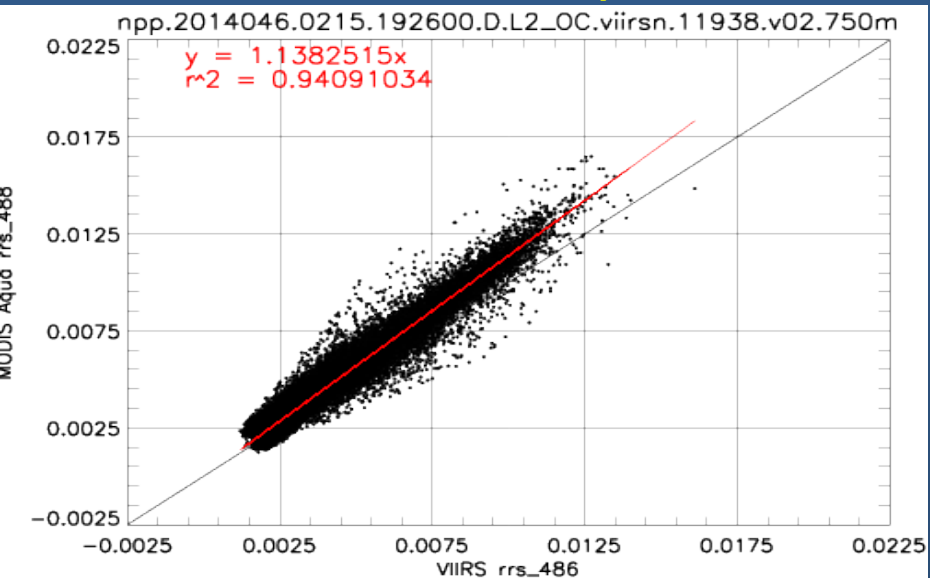
**Suspect
VIIRS
calibration
after
November 1,
2013.**

MODIS(y-axis) vs. VIIRS(x-axis) Comparison

Scatter Plots - MissBight - February 15, 2014



**MODIS rrs values higher (all channels)
48%(412), 30%(443) , 14%(486), 6%(551)**

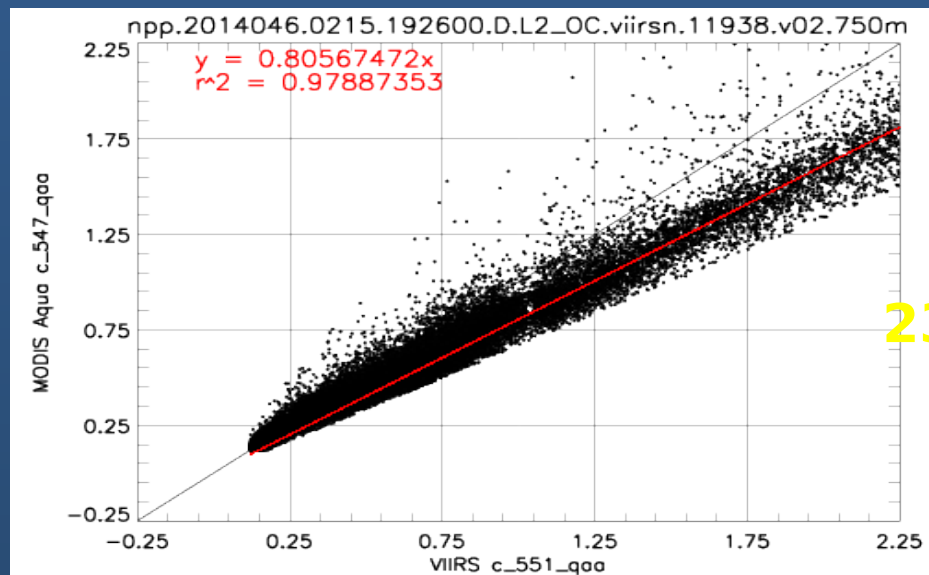
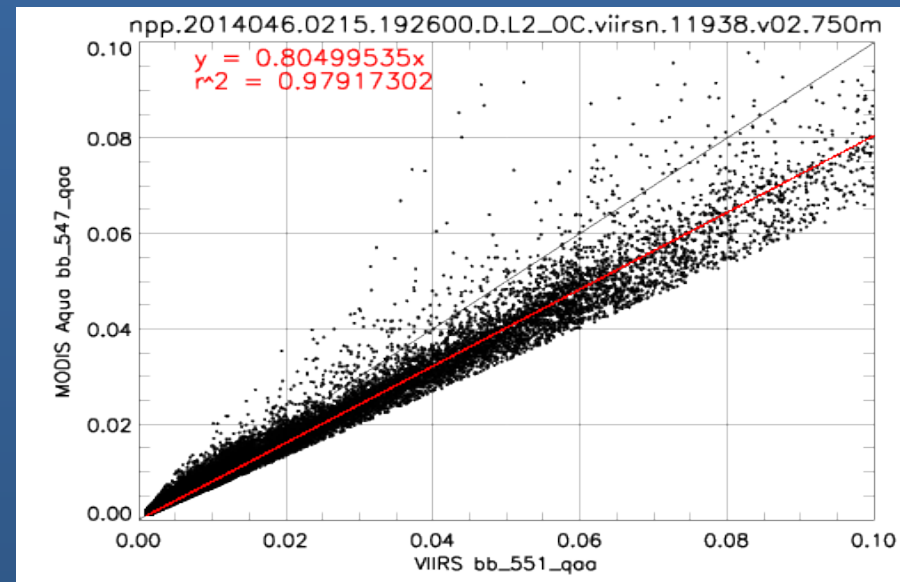
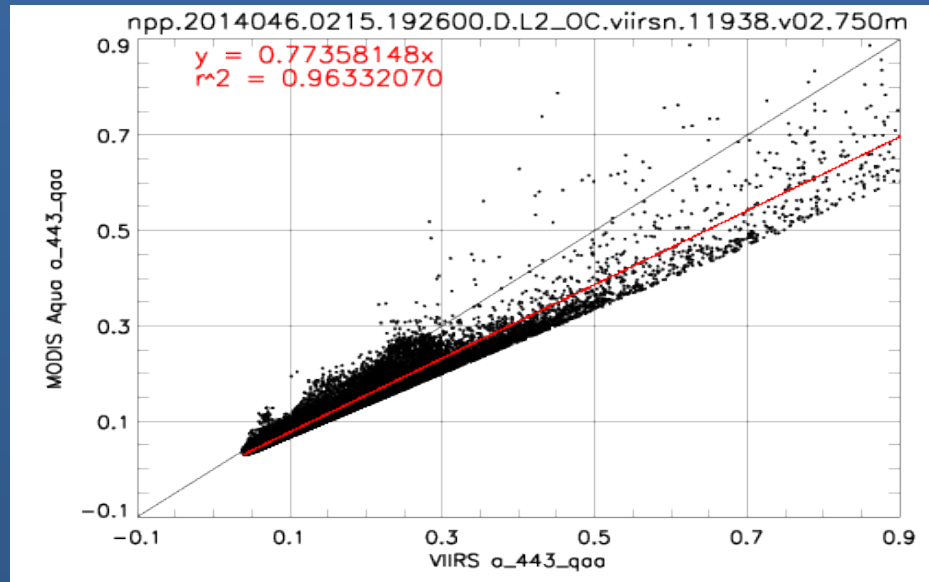




MODIS vs. VIIRS Comparison

MissBight

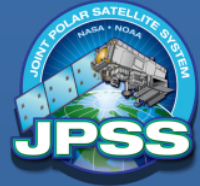
February 15, 2014



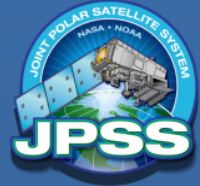
VIIRS (x-axis) IOP values higher than MODIS (y-axis)
23%(a443), 20%(bb551), 19%(c551)



Summary :



- **VIIRS and MODIS are currently generating quality coastal ocean color products (rrs and bio-optical products) in the Northern Gulf of Mexico (within known uncertainty requirements). Overall VIIRS performed better for GEOCAPE cruise (Sep. 2013) and MODIS for Ocolor Cruise (Nov. 2013)**
- **Vicarious calibration gains (MOBY) applied to VIIRS improves ocean color retrievals (lowers rrs values)**
- **Both sensors are capable of generating scientific research quality ocean color data.**
- **No current issues with Navy coastal retrievals(-) for VIIRS and MODIS**
- **Follow-on cruises and ocean color validation planned in near future (coastal and offshore)**
- **Ongoing Cal/Val efforts (NASA, NOAA, Navy, Universities) will continue for VIIRS and MODIS and**



Questions?

See poster 9111-41 (Bowers, et.al)

Tuesday's Poster Session 6:00 - 7:30pm

"Regional Vicarious Gain Adjustment for Coastal VIIRS Products"

We greatly appreciate the support of our NOAA and Navy sponsors.

Thanks to Wesley Goode (NRL), Mike Ondrusek (NOAA), Nima Pahlevan (UMASS) and ZhongPing Lee (UMASS) for providing in situ cruise data.

Appreciate timely support of NAVO and NOAA CLASS for providing VIIRS and MODIS data to support cal/val cruises.

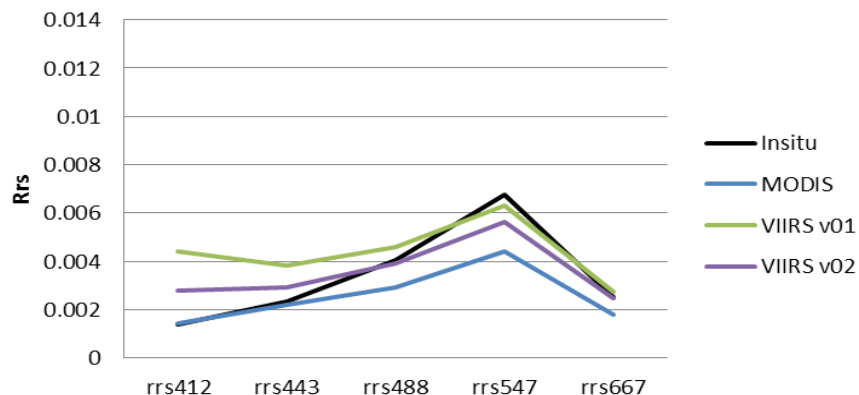


GEOCAPE Cruise (Northern GoMex) September 09 - 19, 2013

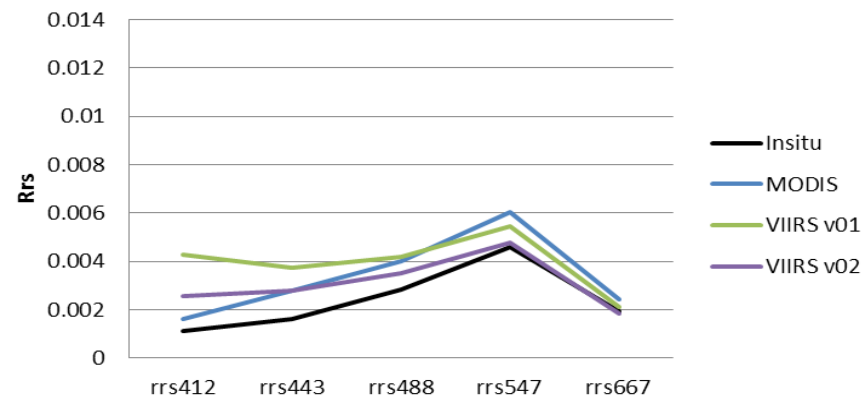


Spectral Rrs(I) Matchups (4 stations)

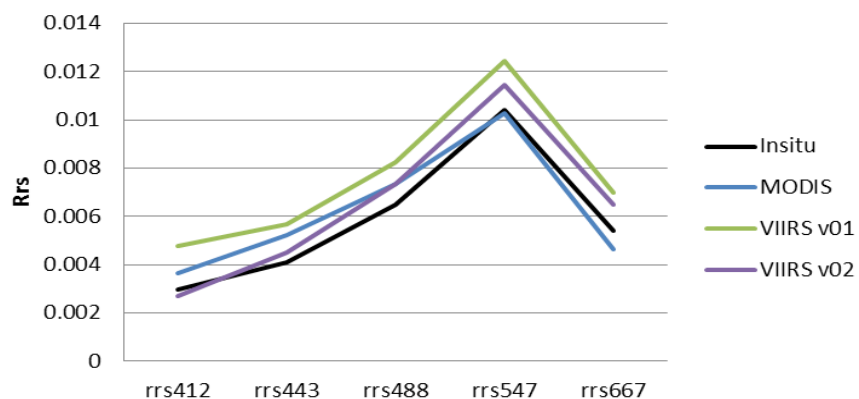
GEOCAPE Gomex - JD254 - 1647



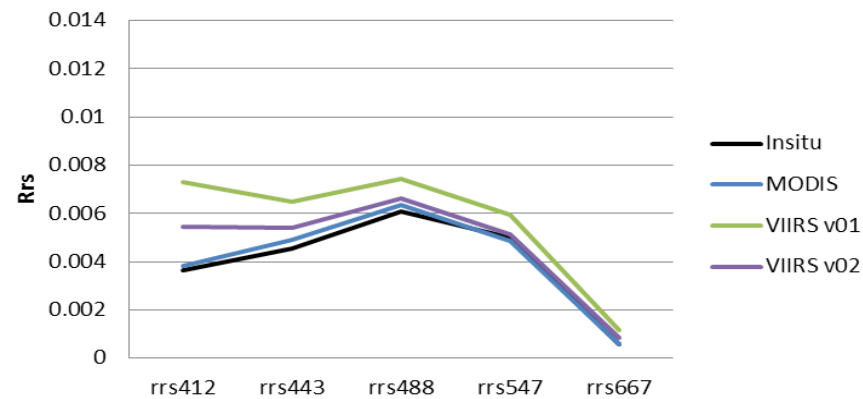
GEOCAPE Gomex - JD254 - 1835



GEOCAPE Gomex - JD255 - 1712



GEOCAPE Gomex - JD257 - 2052



**Insitu:
UMASS/NOAA**

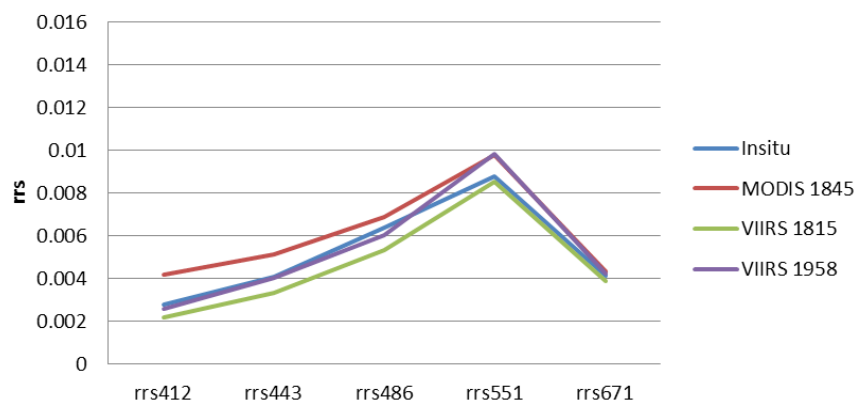


NRL Ocolor Cruise (Mississippi Sound) November 20, 2013

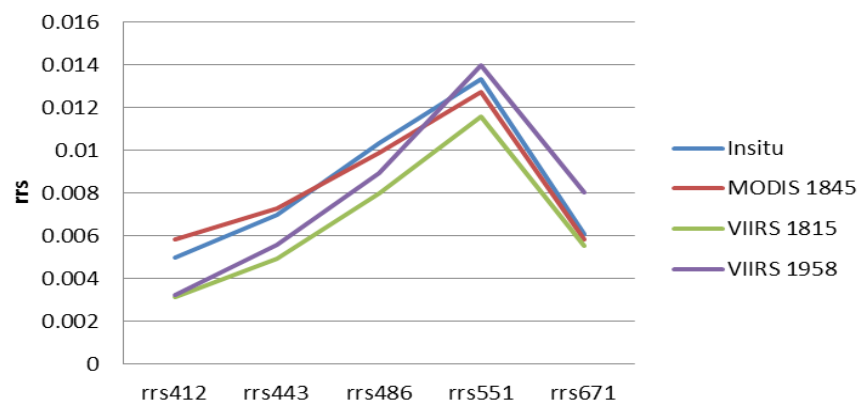


Spectral Rrs(I) Matchups (4 stations)

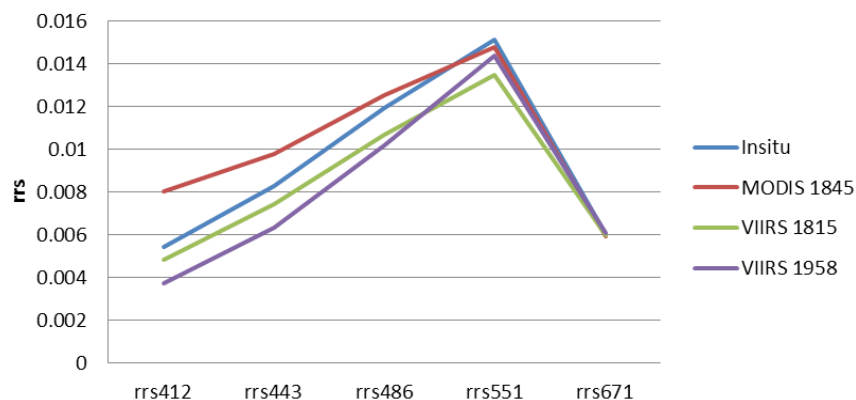
RV Ocolor - MissBight - 11/20/2013 - St2 - 1630



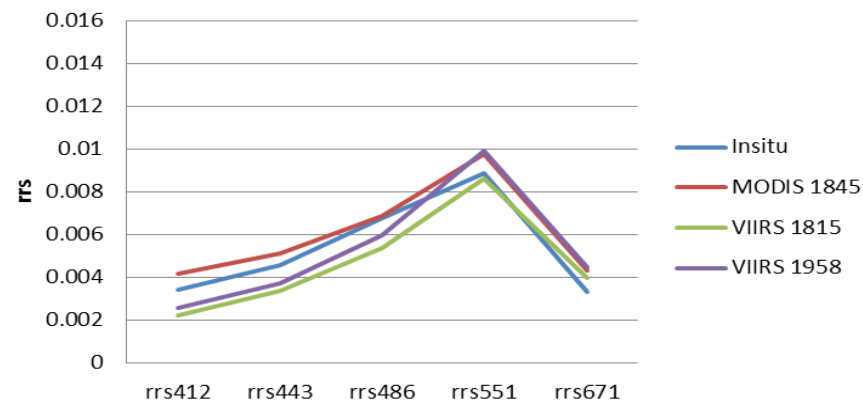
RV Ocolor - MissBight - 11/20/2013 - St3 - 1725



RV Ocolor - MissBight - 11/20/2013 - St4 - 1805



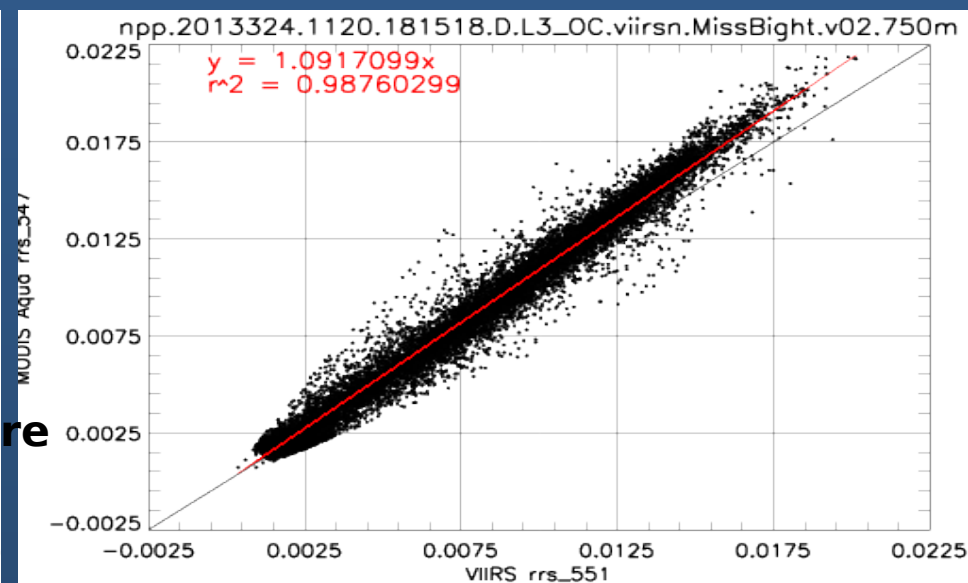
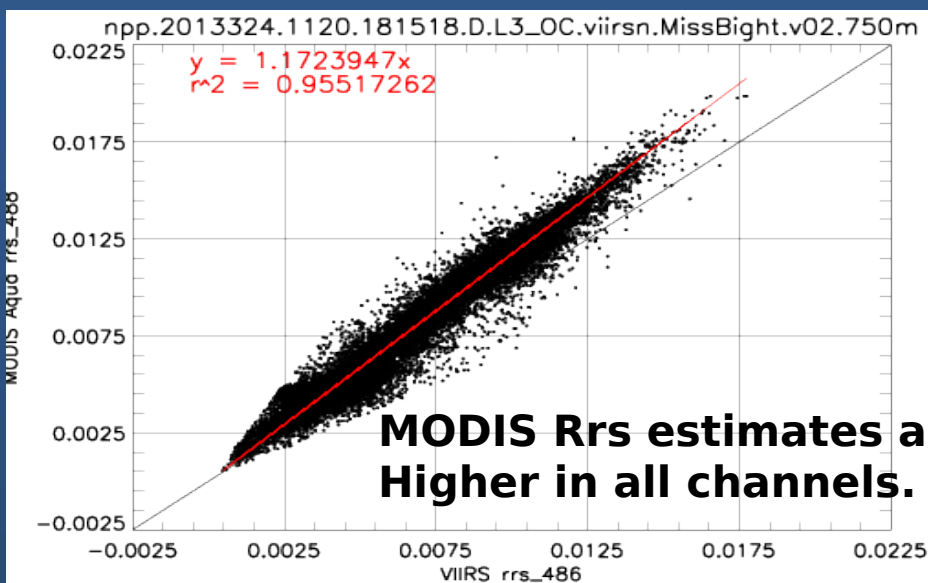
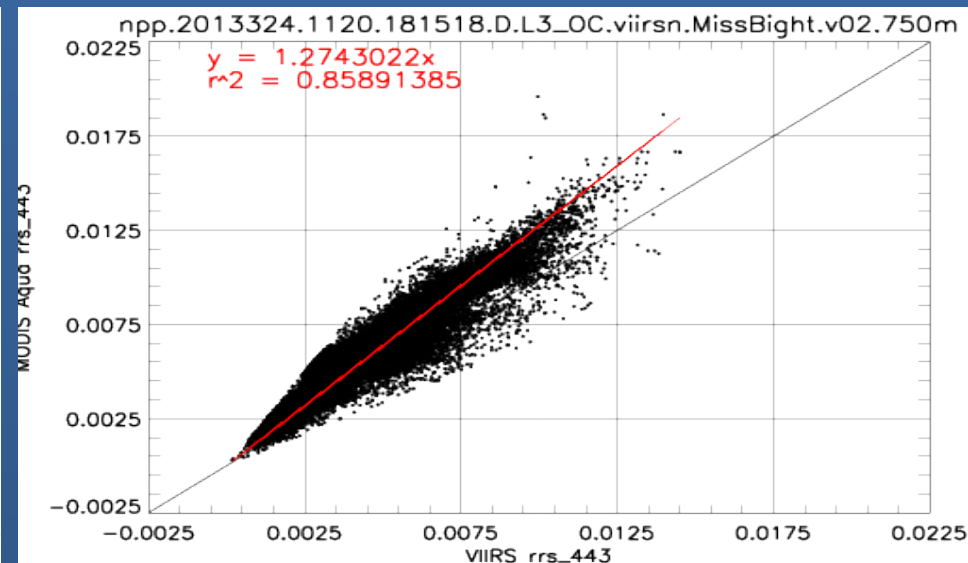
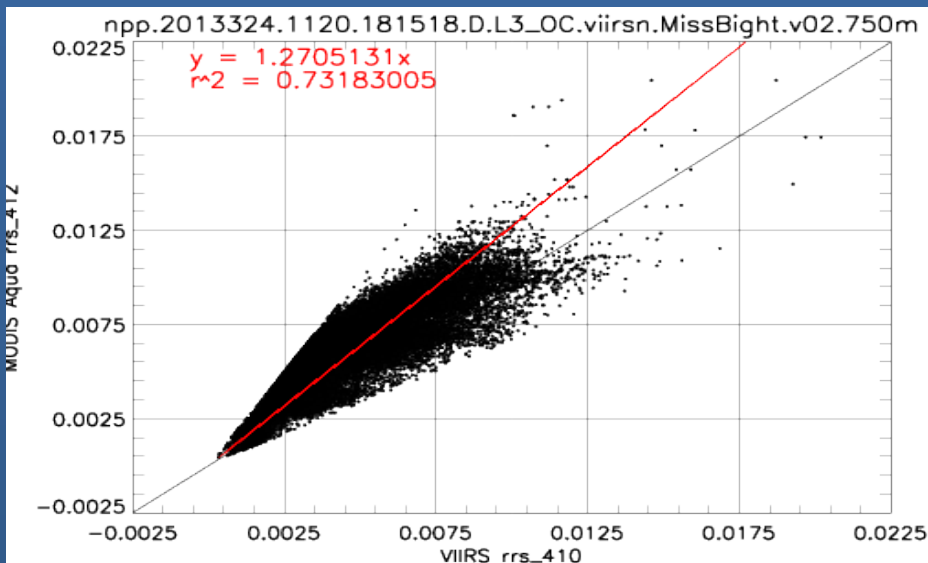
RV Ocolor - MissBight - 11/20/2013 - St5 - 1920



Insitu: NRL



MODIS(y-axis) vs. VIIRS(x-axis) Comparison Scatter Plots - Ocolor Cruise November 20, 2013



**MODIS Rrs estimates are
Higher in all channels.**



MODIS vs. VIIRS Comparison

MissBight

February 15, 2014

